Aalto University
School of Engineering

TES Mindset

AAE- E3080 Thermal Energy Storage Systems

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Learning outcome of this session

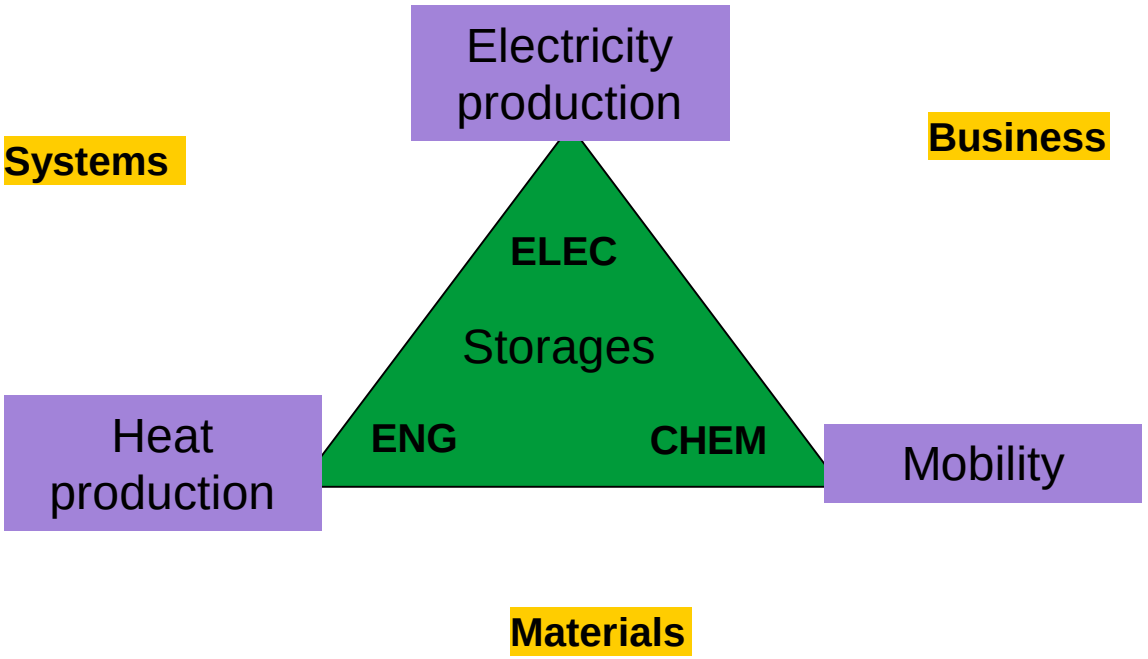
Understand system level approach to thermal energy storage between Power plants, Industry, Community and building level

Connect the need for thermal energy storage create by both RES-Electricity and RES-Heat


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Energy Transition

Energy Transition



How do we create heat right now?

Heat Pumps

Combustion power plants

Excess heat from process industry

What is the size of the boxes?

Peer discussion

How do we create heat now?

RES-electricity
RES-heat

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Basis in Thermodynamics

1st Law: Energy is neither created nor destroyed during a process.

Energy Conversion from one form to another.

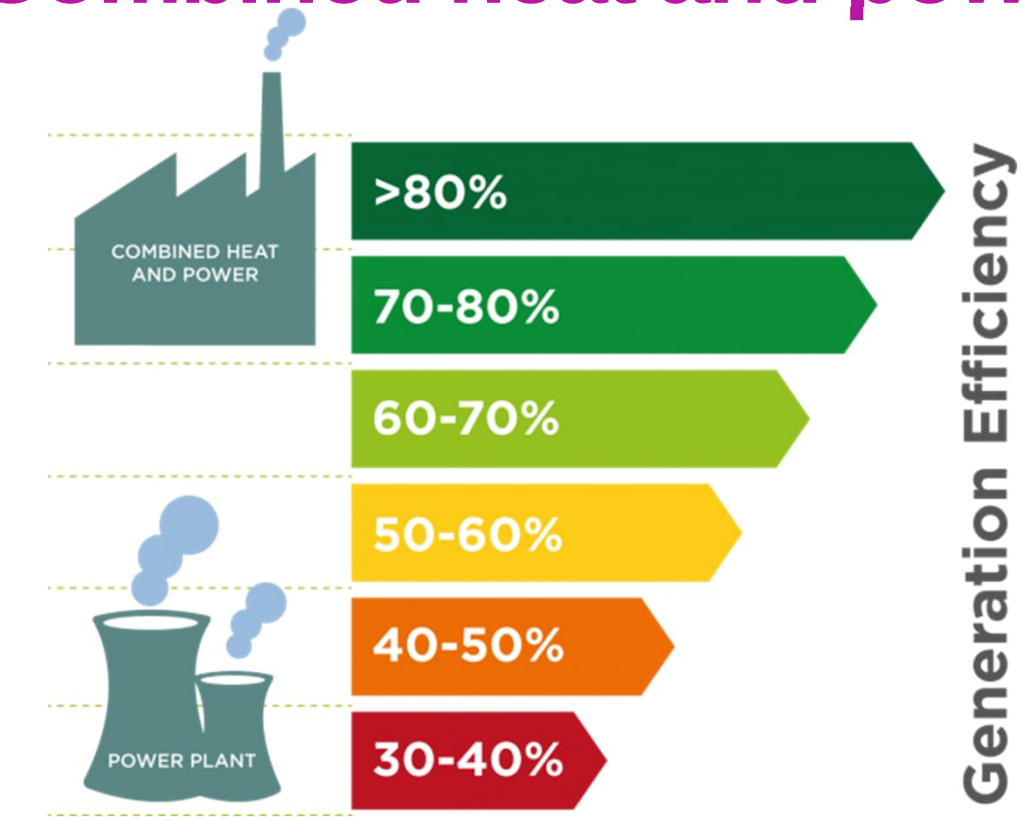
Exergy is the energy that is available for use.

Heat from Combustion

From Coal to Biomass
By Gemco Energy

- Our heat production focus on combustion processes
- Robust, well known technology
- Reliable investment
- **Fuel cost???**

Combined heat and power

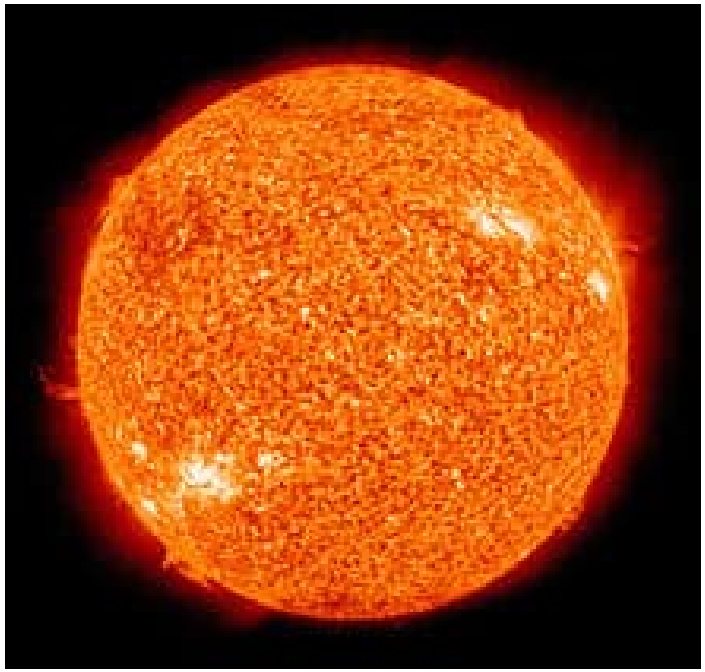


Association of Decentralized Energy

When there is a change in the electricity production

-> Where is the heat then produced?

What possibilities do we have in the RES?



SUN

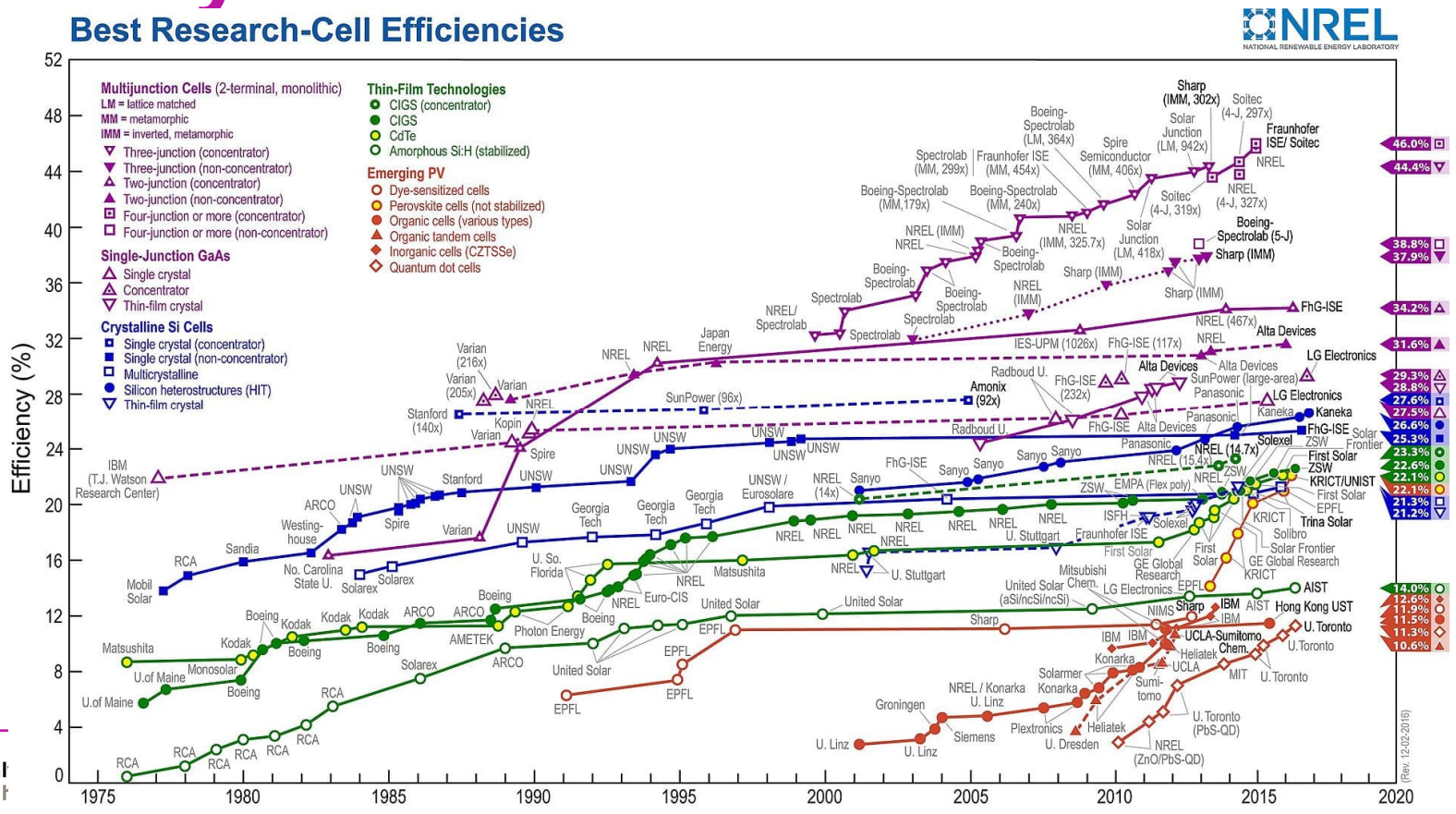
Wikipedia

Solar Technologies

Solar Photovoltaic

- Low efficiency 10-30%
- Wide use
- Expensive materials

Solar conversion to electricity: efficiency



National Renewable Energy Laboratory, 2016

Solar Technologies

Solar Photovoltaic

- Low efficiency 10-30%
- Wide use
- Expensive materials

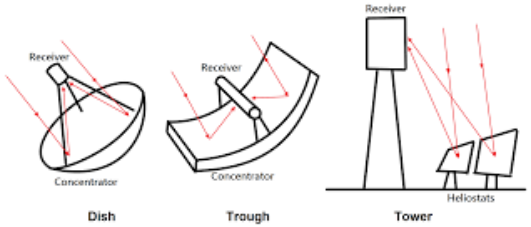
www.365solar.co.uk

Solar Heat

www.zenenergy.com.au

- Higher efficiency (40-70 %)
- Limited use
- Cheap materials

efergy.com



commons.wikimedia.org

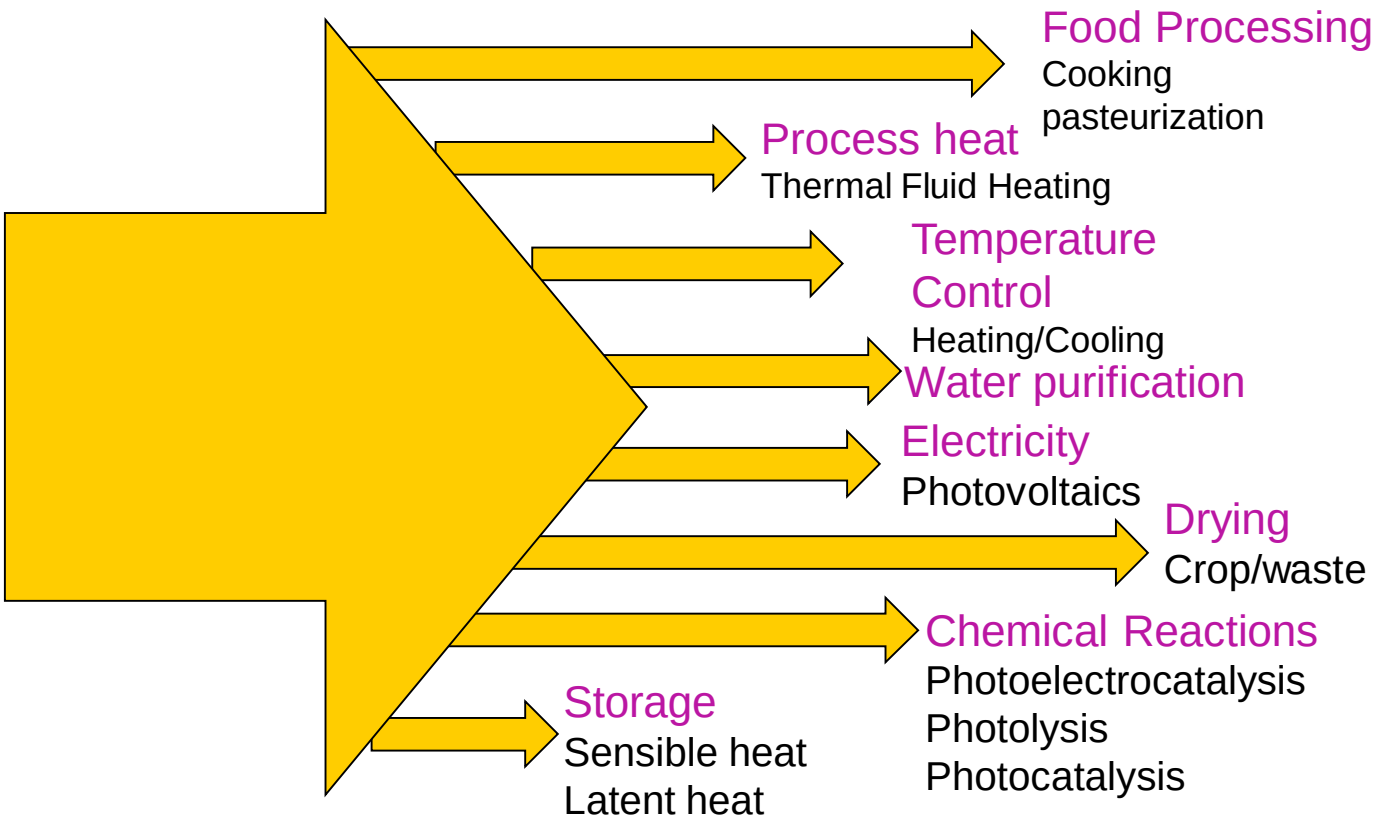
Concentrated Solar Power (CSP)

- Higher efficiency (25-60 %)
- Targeted use [high temp.]
- Cheap materials

Using the heat of the Sun
Is that a new thing?

Wikipedia

Where can we use solar heat?



What are the heat levels obtained from Sun?

Solar Heat

www.zenenergy.com.au

Up to 100 ºC

Concentrated Solar Power (CSP)

efergy.com

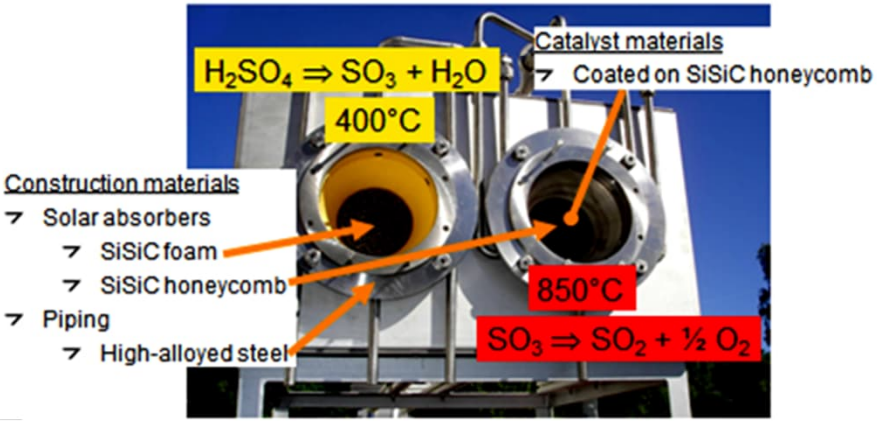
From 200 - 800 ºC

Solar Furnace - *French Pyrenees*

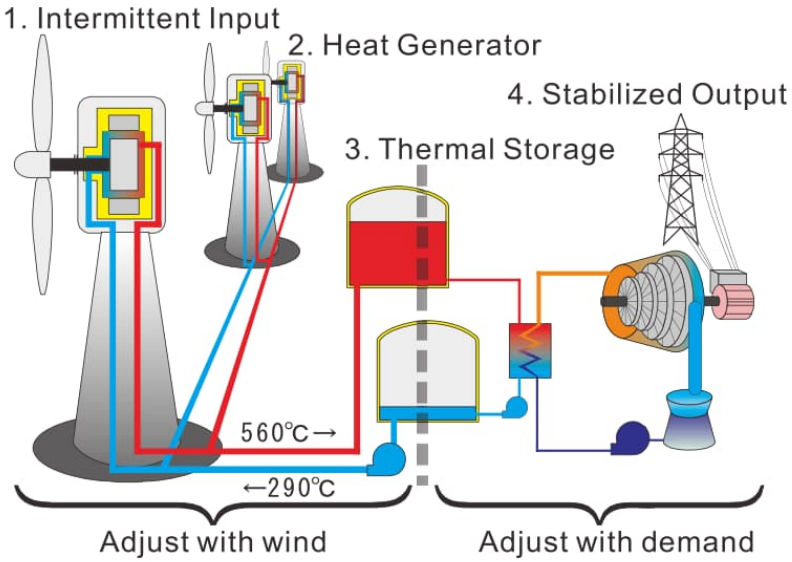
Up to 3 500 ºC

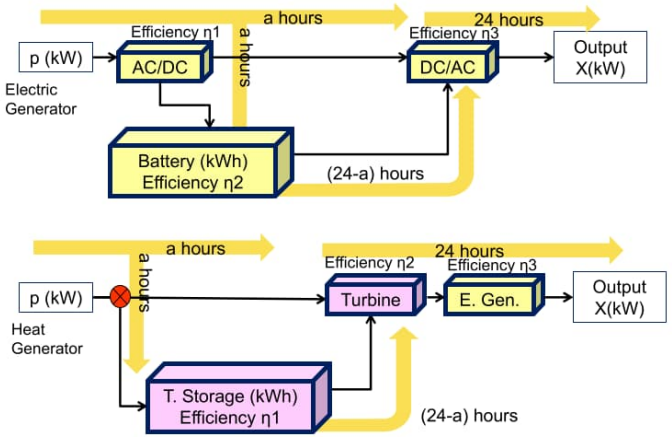
Can we go industrial?

SOL2HYs project
Horizon 2020



From Wind to heat - directly

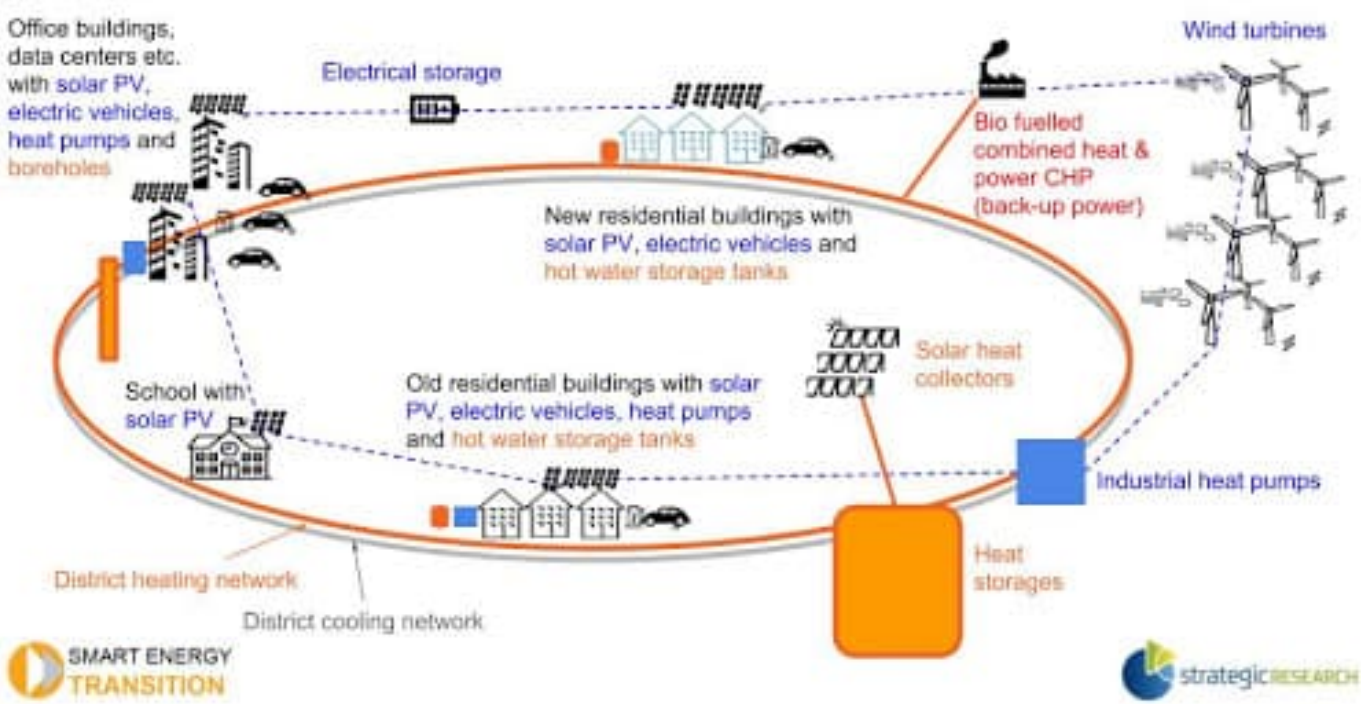




Comparison
Wind + battery (upper)
Wind + TES (lower)

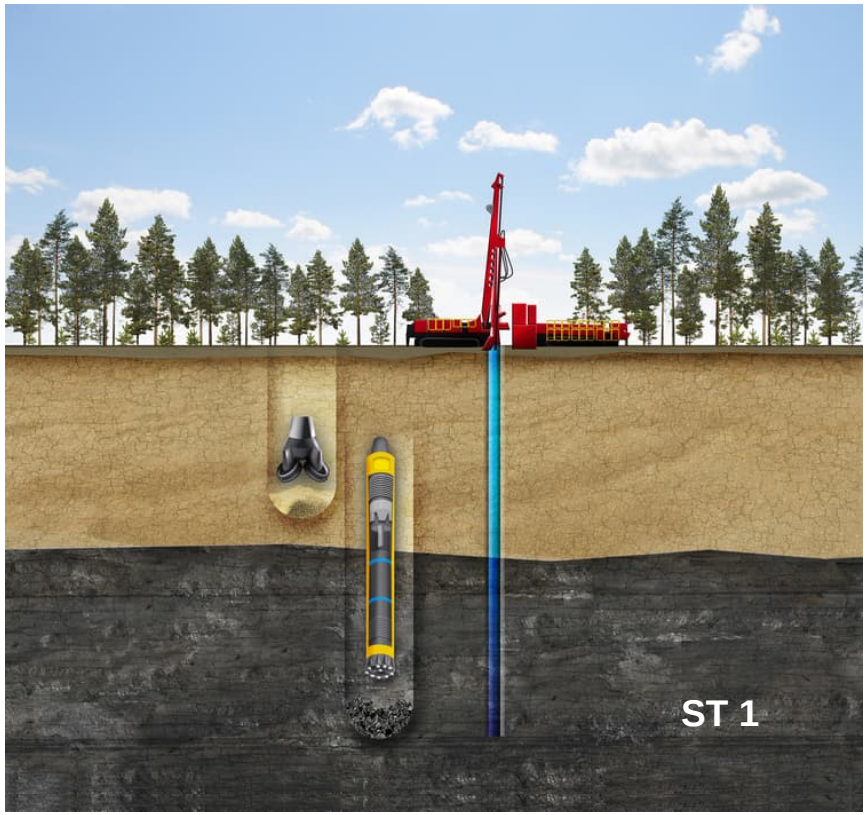
Toru Okazaki et al. Concept study of wind power utilizing direct thermal energy conversion and thermal energy storage. *Renewable Energy* 83 (2015) 332.

From Wind to heat – through conversion



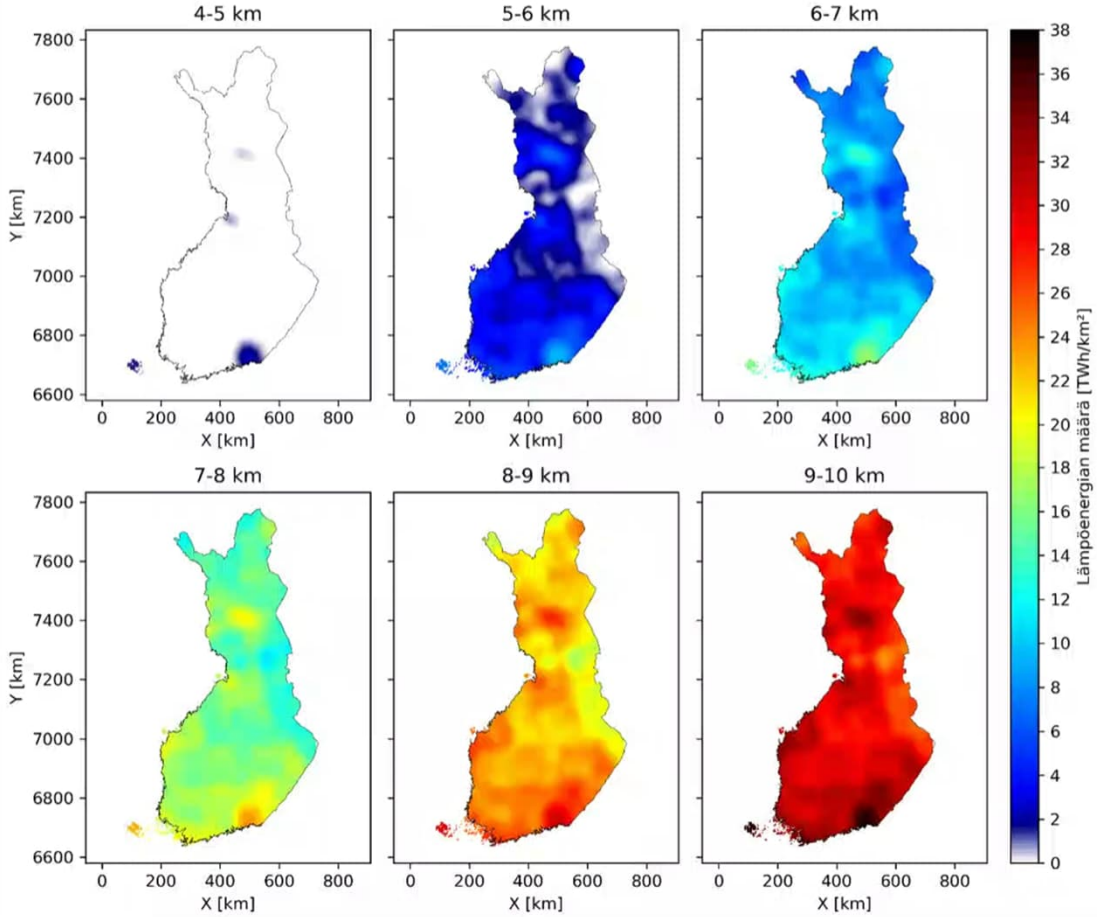
Excellent Reading Material from Finland (in English):
http://smartenergytransition.fi/fi/julkaisut/publications/

Geothermal heat production (ST1, deep)



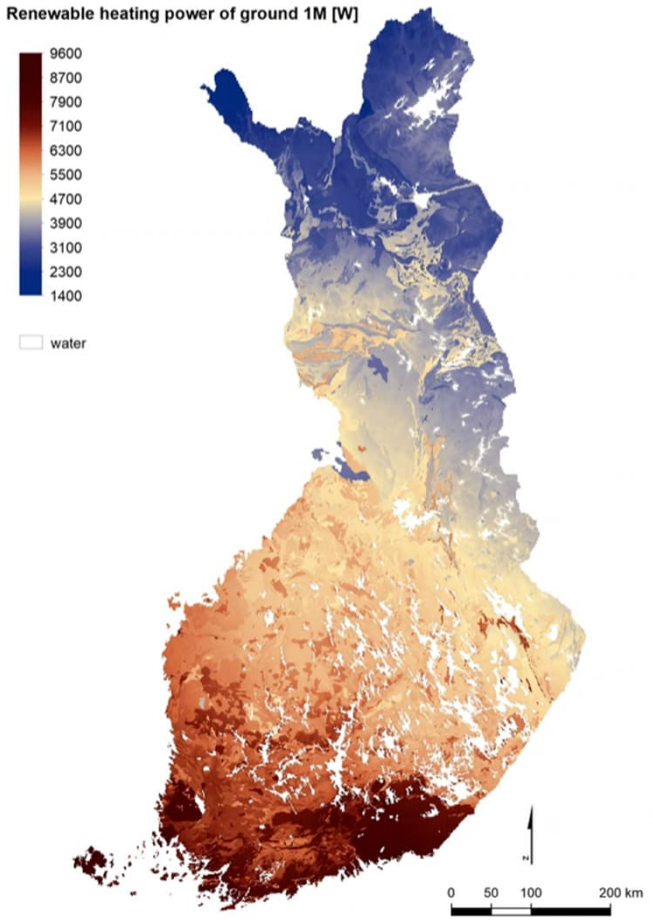
Nordberg, J. and Rask, M.; Suomen ensimmäinen geoterminen lämpövoimala Otaniemessä, Case Study, Finnish http://urn.fi/URN:ISBN:978-952-60-8949-2

Geothermal heat production (deep)



GTK, CLC RePowerEU webinar, 1.4.22

Geothermal heat production (shallow)



GTK, CLC RePowerEU webinar, 1.4.22

Peer discussion
-
What renewable options do we have for heat production?

What other heat sources we can have?

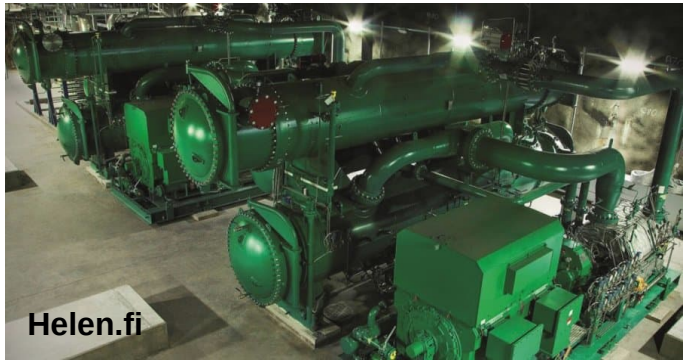
Industrial excess heat

Municipal Waste to heat

In Vantaa – operated all year, heat all year around

Low temperature heat sources

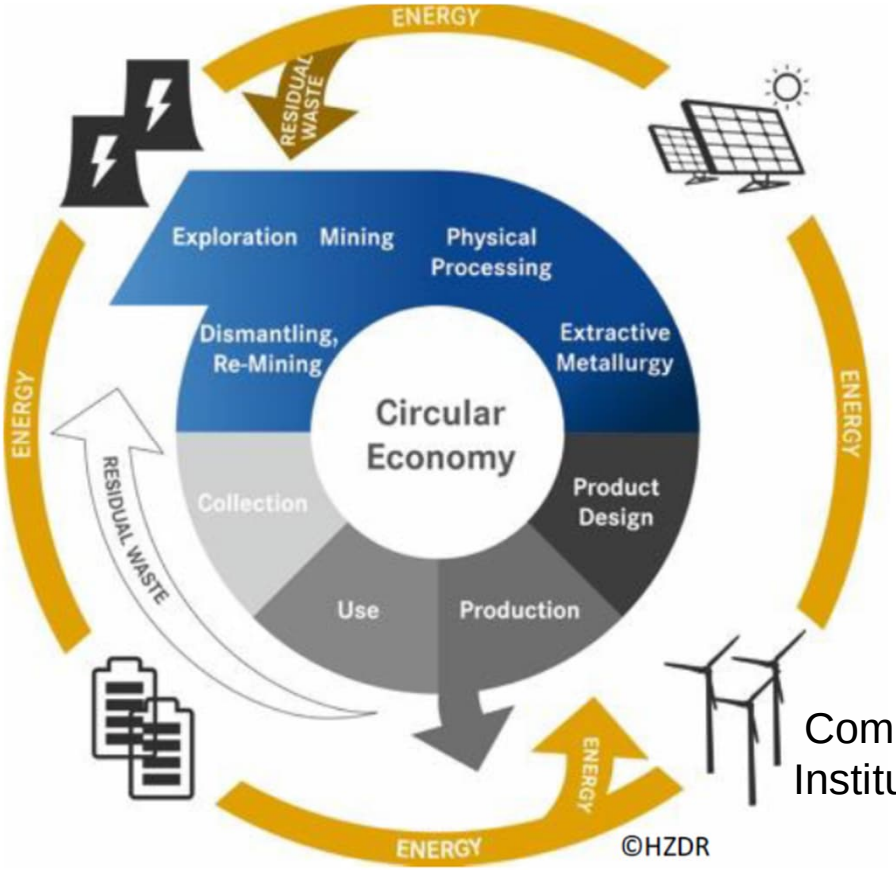
Data Centers



Role of Heat Pumps?

Lighting

Circular Economy vs. Energy



Complementary to Helmholtz Institute. Director prof. Markus Reuter

Timescale Intermittency

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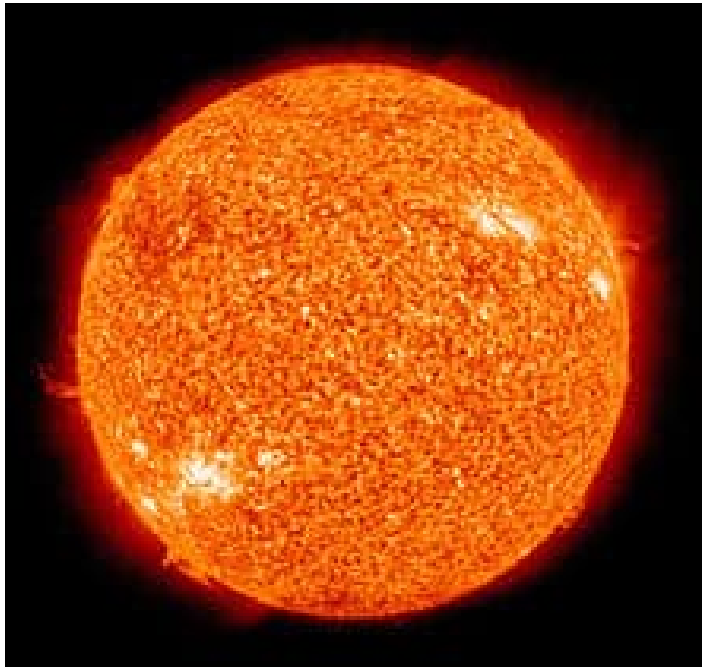
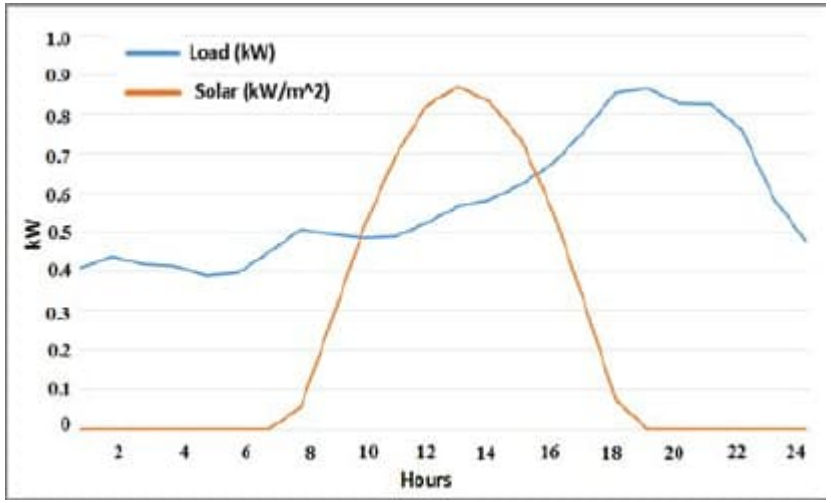
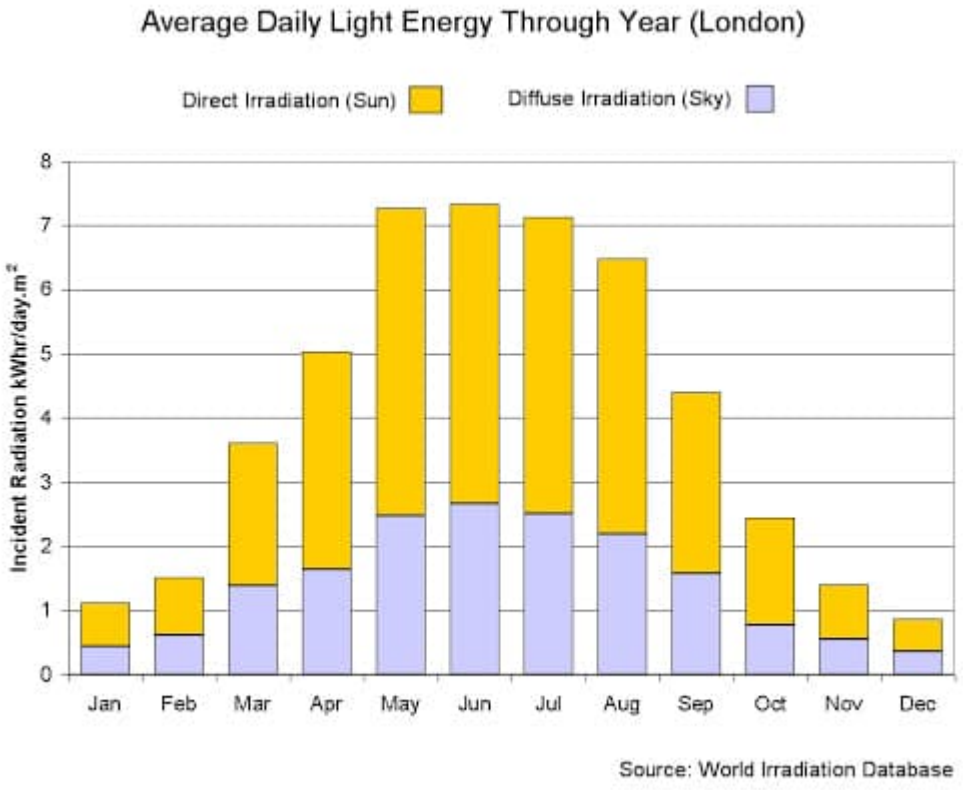
Heat available -> how to prolong it with storage – Short term





Vinayagam Arangarajan et. Al. Optimum design and analysis study of Stand-alone residential solar PV Microgrid. *Conference Paper* (2014), DOI: 10.1109/AUPEC.2014.6966522

Heat available -> Seasonal Storage



Key ideas needed for the seasonal questions…

The size of the storage

What is your take home message from today?